ment is that it appears secondary to our main aim in the Western World, that of economic progress at all costs. Our whole way of life is geared to an increase in the standard of living. Although not a trained philosopher, I think the quality of life is more important than its material comforts and this greed for ever-increasing ease of life must either stop voluntarily or it will be forced to a halt by some rather unpleasant circumstances. This, of course, means nothing short of a social revolution, which would not happen overnight, if at all. Education in its widest sense is possibly our only hope for survival. and educational revolutions tend to take a generation or two in which to take effect. This may well be too late at this already late stage. I am not a natural pessimist and hope something will happen to prove me wrong. If so, it will have to happen in the next decade if my children are to enjoy a small fraction of the contact with the natural world in which I have been fortunate enough to be able to participate.

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A note on the distribution of the Rhopalocera on the Island of Sao Jorge—the Azores

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Introduction

The Azorean archipelago, situated in mid Atlantic between Portugal and North America, consists of nine islands geographically arranged into three groups. The south easterly group comprises Santa Maria and São Miguel. The central group consists of Terceira, Graciosa, São Jorge, Pico and Faial. The north westerly group includes Flores and Corvo. The present



the survey (.....).

study was made during the Chelsea College (London University) expedition to the island of São Jorge from July to September 1965.

São Jorge lies between long: 28' West and Lat: 38' North. The climate of the island is extreme oceanic with moderate rainfall throughout the year, high relative humidity and a small temperature range (Tutin 1953). The island of São Jorge is 4 km wide at its maximum point and 27 km long and has a backbone of quiescent volcanic cones reaching a maximum altitude of 900 metres (Fig. 1).

There is a distinct sequence of vegetation on the island passing from sea level to the summit. The sequence passes from open woodland to closed woodland, to scrub, to a combination of scrub and pasture and finally to open damp pasture. Each zone is characterized by certain plant species (Fig. 2). A similar vegetation zonation is found on the neighbouring island of Pico (Marler & Boatman 1952).

Drouet (1861) compiled the first list of Azorean Lepidoptera and this list was improved by Godman (1870). In 1903 Ogilvie-Grant collected Azorean Lepidoptera (Warren 1905). In more recent years Rebel (1940) and Carthy (1957) have published lists of Lepidoptera collected on the Azores.

Only four species of Rhopalocera were found on São Jorge during our stay in 1965.

Rhopalocera

PIERIDAE

Colias croceus Geoffroy

Previous records: Godman (1870), Rebel (1940), Carthy (1957).

Pieris brassicae azorensis Rebel.

Previous records: Godman (1870), Warren (1905), Rebel (1940), Carthy (1957).

LYCAENIDAE

Lampides (Polymmantus) boeticus L. Previous records: Rebel (1940), Carthy (1957).

SATYRIDAE

Hipparchia azorina Strecker.

Previous records: Rebel (1940), Carthy (1957).

An endemic species. Regarded by some authors as a subspecies of *H. aristaeus*.

It soon became apparent that these species exhibited a well defined distribution in respect to altitude. The altitudes at which Carthy had collected his specimens on Pico suggested a similar situation on that island (Carthy 1957). It was decided to make a more detailed examination of the apparent zonation of these four species taking into account altitude, climate and vegetation.

Methods

The survey was carried out on 1st September 1965 in sunny weather with a slight breeze blowing. The apparatus consisted of an altimeter, stop watch and four hand tally counters.

A hike (Fig. 1) was made from Fajo do Ouvidor, on the north coast, via Norte Grande (300 metres) and Santo Antonio (460 metres) across the central ridge of extinct volcanic cones (790 m) to Urzelina on the south coast. At every 60 metre contour a count was made of the number of each of the four species observed in a period of three minutes. The species were counted simultaneously using the tally counters. The counts were all made during periods of direct sunlight. At each counting station a note was made of the exposure to wind, general flora zone and the relative abundance of the more common flora. The latter were arbitarily graded from 0 (absent) to 5 (very abundant). The types recorded in this manner were: *Mentha* sp., *Zea mais*, *Brassica* sp., *Erica azorica*, *Graminae* sp., *Carex flava* and *Polytrichum commune*.

During the period of our stay on the island we climbed from Urzelina up to the central ridge of volcanic craters on 30 separate occasions. The main reason for these trips was the collection of coleoptera (Marsden 1969) from the crater of a volcano that had erupted in May 1808. On these climbs we also collected Rhapolocera and recorded the altitude at which the captures were made.

Meterological recordings were made at 210 metres and 790 metres.

Results and Discussions

1. Climatic. The extent of the cloud coverage at 210m and 790m is given in Table 1. The central ridge of volcanic peaks was often clear in the early morning but by late afternoon was completely enveloped by dense mist. No humidity recordings are available as the cobalt thiocyanate papers, that had been stored in glycerine, were found to be ruined on their return to England. The mean annual relative humidity at Horta, on the neighbouring island of Faial, is 81.5% (Tutin 1953). The maximum and minimum air temperatures recorded at 210 and 790m are shown in Table 2.

 TABLE 1.—The extent of cloud coverage recorded at 210m and 790 m on
 Sao Jorge between July and September 1965.

	Total Cloud Coverage	Partial Cloud Coverage	Clear Daus
2 10m	6	10	14
790m	10	12	8

 TABLE 2.—The air temperature recorded at 210 m and 790 m on 30 days

 between July and September 1965 on Sao Jorge

			Total Cloud Coverage	Partial Cloud Coverage	Clear Days
210 m			Ŭ		
Max.	Temp.	°C	24	28	35
Min. 790 m	Temp.	°C	81	17	13
Max.	Temp.	°C	18	23	24
Min.	Temp.	°C	12	11	7

2. Vegetation. The main plant zones recorded on the south and north faces of the island are shown in Fig. 2. The relative abundance of certain species recorded at every 60m contour are shown in Table 3. The mint plant is the only plant that was recorded at almost every 60m contour. Certain vetches were also very common being abundant in the low pasture land. The region from sea level to 420m on the north side of São Jorge is much steeper than the corresponding area on the south. This is reflected in the very small cultivated and *Erica* pasture zones found on the north side.



FIGURE 2.—Diagram to show the main vegetation zones on the north and south sides of the island of Sao Jorge between the village of Urzelina on the south and Fajo do Ouvidor on the north.

TABLE 3.—The type of plant zone and the abundance of certain plant species at each 60 metre contour between Urzelina on the south coast and Fajo do Ouvidor on the north coast.

A 1+i+i	obu								
(met	res)	Zone	Α	В	С	D	E	F	G
	60	Woodland	—	2	2	—	—	—	-
	120	Cultivated		5	3	—			
	180	Cultivated	—	5	2	—	—	-	—
	240	Cultivated	1	4	2				—
	300	Woodland	3	—	—	—	1	-	—
	360	Wood/Pasture	5		—	1	4	—	
SOUTH	420	Erica/Pasture	5		—	1	4		
	480	Erica/Pasture	5			2	5	3	

	540	Erica/Pasture	2		—	3	5	3	
	600	Erica/Pasture	4			1	5	3	—
	660	Pasture	3				5	_	3
	720	Pasture	3	—		4	4		2
	790	Pasture	2	—			5		3
	720	Pasture	4				5	3	3
	660	Pasture	2				5	3	
	600	Pasture	2				5	3	
	540	Pasture	3				5	_	
	480	Pasture	4	—			4		
NORTH	420	Erica/Pasture	3			2	5	_	
	360	Pasture	3			2	5		
	300	Cultivated	2	4	1		3		
	240	Cultivated	2	4	1		2		
	180	Woodland	4	—			_	_	
	120	Woodland	2			_	_		
	60	Woodland	3	1		_	_		

A=Mentha sp., B=Zea mais, C=Brassica sp., D=Erica azorica, E=Graminae sp., F=Carex flava, G=Polytrichum commune. The abundance of the plants is arbitrarily graded between — (absent) and 5 (very abundant).

3. Rhopalocera. P. brassicae azorensis was not observed above 540m and was most common in cultivated areas (Fig. 3). More individuals were recorded on the heavily cultivated south side than on the steeper north side. Many of the small fields of cabbage plants were totally destroyed by the activities of the vast numbers of the larva of P. brassicae azorensis.



FIGURE 3.—Relationships between the numbers of P. brassicae azorensis (\bullet — — \bullet) and C. croceus (O— — — O) counted and altitude.

Colias croceus was not found below 240m on the north side and 360m on the south and the numbers reached a peak in the lower drier pasture land (Fig. 3). The lower pasture zone extends between 360m and 660m on the south and 360m and 720m on the north. The zone is generally below the heavy cloud coverage and is consequently of a drier nature than the upper pasture. The vegetation mainly consists of coarse grasses, clumps of *Erica azorica* and *Calluna vulgaris* with numerous small flowering plants including vetches that are common food plants of *C. croceus*. *C. croceus* is generally found in heath and open places up to about 1,800m.

Hipparchia azorina showed the most limited distribution of the four species being confined to the upper damp pasture zone (Fig. 4). This is above 480m on the north and 540m on the



FIGURE 4.—Relationships between the number of L. boeticus (O - - - O) and Hipparchia azorina (\bullet ----- \bullet) counted and altitude.

south. In this area the butterfly is very abundant and at times the air is literally thick with butterflies, sluggish in flight and very easily captured. The limiting factor in the vertical distribution of *H. azorina* appears to be the diet of the larva. A larva, probably that of *H. azorina*, was found in great numbers amongst the grass roots at the higher altitudes. It is possible that *H. azorina* as well as *P. brassicae azorensis* may be of some economic importance on the island. There is evidence that some agent is doing considerable damage to the upper pasture

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zone. It is this zone that supports the large herds of Friesians found on São Jorge. The larva of *H. azorina* may contribute to this damage.

Lampides boeticus was the most widely distributed of the four species and its distribution does not appear to be related to altitude (Fig. 4). In the cultivated and woodland areas the species was less common. There does, however, appear, to be a significant correlation between the occurrence of mint plants and the number of L. boeticus counted (Fig. 5). This probably



FIGURE 5.—The relationship between the number of *L. boeticus* counted and the abundance of *Mentha* sp. The *Mentha* is graded between 0 (absent) and 5 (very abundant).

p 0.05 between abundance of Mentha 3 and 4 p 0.01 between abundance of Mentha 4 and 5

p 0.001 between abundance of Mentha 2 and 4

reflects the common habitat of this species which is flowery banks and other rough places up to 1,800m.

The route taken on this survey was chosen for convenience as it afforded an accessible route from the north coast over the central peaks to the south coast. The recordings made on the other 30 climbs from the village of Urzelina to the central ridge of peaks confirmed that the distribution of the four species is typical of São Jorge. On visits to the neighbouring islands of Pico and Faial the four species were collected in the same vegetation zones. Carthy (1957) found the four species on Pico and the altitudes at which the specimens were collected correspond with the floral zones on Pico (Marler and Boatman 1952) in which the species were generally recorded on São Jorge. It is thus the plant zonation that probably determines the distribution of the four species on these islands while the plant zonation is affected by climate and consequently altitude.

The method of investigation was devised in the field using available equipment. The possibilities for errors and inconsistencies are obvious. The fact that the recordings were made at different times of day, varying from early morning to late afternoon, was unavoidable. In an attempt to standardize the results all the counts were made during periods of direct sunlight. At higher altitudes this often involved waiting at observation points for a considerable time before a count could be made.

It is probable that the number of each species counted at each 60m contour is subject to error as individuals may have been counted more than once. The relative numbers, however, probably reflect the true situation.

The results demonstrate the few number of butterfly species present on São Jorge but the abundance in number of those species that are present particularly under suitable ecological conditions. It was the abundance in numbers that made the present very simple survey feasible.

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